// INDUSTRIAL STANDARDIZATION

Formerly ASA BULLETIN

INDUSTRIAL STANDARDIZATION

A MONTHLY REVIEW

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The American Standards Association is organized to provide systematic means of cooperation in establishing American Standards to the end that duplication of work and the promulgation of conflicting standards may be avoided; to serve as a clearing house for information on standardization work in the United States and foreign countries; to act as the authoritative American channel in international cooperation in standardization work

A System of Standard Paper Sizes as Developed in Europe

by

John Gaillard, *Mechanical Engineer*
American Standards Association

A survey of the development and present status of European standard paper sizes; their relation to American conditions

During the last ten years the larger part of Continental Europe has freed itself from the chaos of uncoordinated paper sizes that had grown up in the course of time. Efforts to systematize the paper size situation have been made before—in fact more than a century ago, as we shall see later—but failed. The great success of the latest effort, originated by a German, Dr. Porstmann, is due not only to its own merits but also no doubt in a large measure to the fact that it was developed about the time when a strong national standardization movement was growing in a number of countries—shortly before the end and immediately after the war. In Germany a national standardizing body was founded in 1917, its purpose being the promotion of industrial standardization and the coordination of efforts in this field as a means of improving the national economic system. A plan to create order in the paper size situation, with consequent benefits to paper manufacturers, distributors, and users, and furthermore to the manufacturers of machinery and equipment for producing and fabricating paper and printed matter, offered tremendous possibilities for improving the technical and economic efficiency of industry and commerce. The German body, therefore, strongly backed the system developed by Dr. Porstmann and this eventually became a national standard. This standard was subsequently taken over by 12 other countries, as follows: Austria, Belgium, Czechoslovakia, Finland, Holland, Hungary, Japan, Norway, Poland, Roumania, Russia, and Switzerland, and is under consideration for adoption in Denmark, France, and Sweden.

Continental Europe may therefore rightly claim that it is well on its way to have multi-national uniformity in the matter of paper sizes. One cannot yet speak of general international uniformity, as the system concerned has not been adopted by such important industrial countries as the United States and Great Britain, in neither of which, incidentally, any national standard system of paper sizes has as yet been established. The principles underlying the European system, and the wide extent to which it already has been adopted, make it worth while to consider the basic features of this system more closely.

The European system of paper sizes comprises several coordinated series of sheet sizes based on a combination of three principles, as follows:

Principle 1. Each sheet of a series is obtained from the next larger sheet by halving the latter crosswise.

Principle 2. All sheets have the same shape; that is, the ratio between the width and the length of the sheets is constant. As simple mathematics will show, this result can be attained only if this ratio is $1 : \sqrt{2}$, or about $1 : 1.41$.

Principle 3. The basic sheet, from which the other sizes have been derived, has an area of

INDUSTRIAL STANDARDIZATION
is New Name of ASA BULLETIN

Beginning with this issue the name of the ASA BULLETIN has been changed to INDUSTRIAL STANDARDIZATION, with the subtitle A MONTHLY REVIEW PUBLISHED BY THE AMERICAN STANDARDS ASSOCIATION. The change has been instituted in order to indicate through the name of the publication the scope of its contents, which covers the field of standardization in general and is not confined to ASA activities.

one square meter (10.764 square feet), the unit of area in the metric system of measurement.

The application of the Principles 1 and 2 to a paper size system is illustrated by Figure 1.

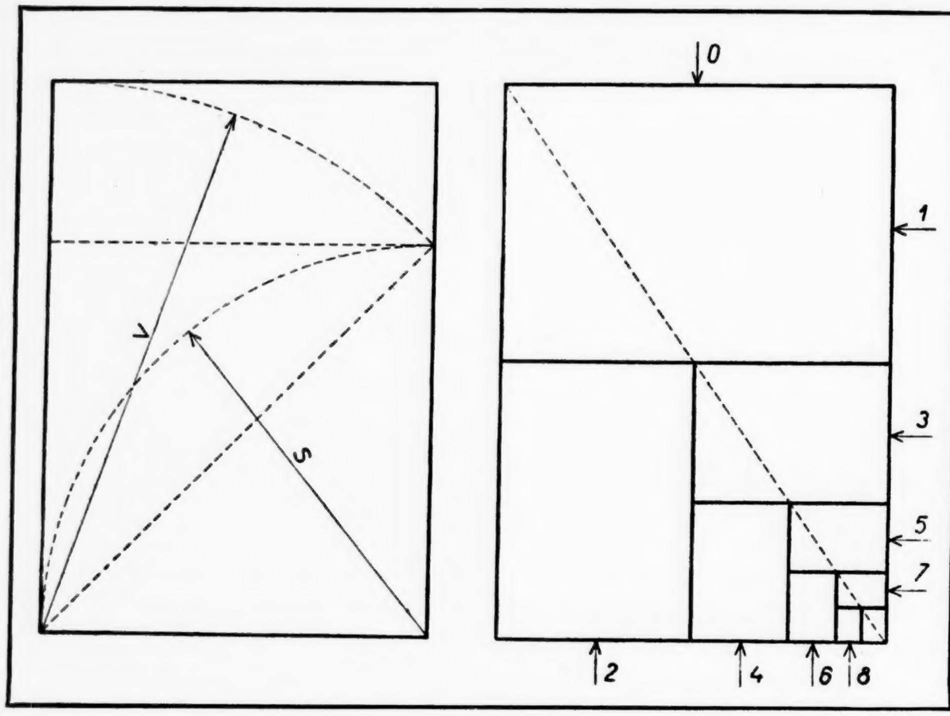

FIGURE 1

Diagrams showing characteristics of paper size series based on ratio 1 : $\sqrt{2}$ between width and length

Halving a sheet of paper is the simplest and most natural method of obtaining smaller sheets and is, therefore, practically as old as the use of paper. Principle 1 therefore needs no further comment.

Principle 2, involving congruity of all sheet sizes, has special significance in practice. In fact, it permits of reproducing the contents of a given sheet on a sheet of any other size with maximum efficiency as to utilization of the space available, while conserving the same appearance throughout. For example, a picture may be reduced to half its original size or enlarged to twice that size, and in either case the reproduction will fit the corresponding sheet in exactly the same way as the original picture fitted the original sheet. This is important from the viewpoint of reproduction technique, particularly in cases where value is laid on the artistic effect. With no width-to-length ratio other than 1 : $\sqrt{2}$ could this result be obtained.

Principle 3, that of starting from a basic sheet with an area of one square meter, presents an advantage in determining the weight of paper sheets. In metric countries the weight of paper is usually expressed in grams per square meter,[1] and in the system under discussion the value concerned will therefore apply to the basic sheet.

As early as 1796, the German physicist Lichtenberg called attention to the significance of ratio 1 : $\sqrt{2}$. Around 1912 its importance was stressed again by the famous German scientist Wilhelm Ostwald, who then was making a special study of the paper size problem. He proposed a system that was also based on three principles, two of which were identical with Principles 1 and 2 mentioned above. The third principle was different, inasmuch as Ostwald adopted a basic sheet having a length of one meter, instead of a sheet with an area of one square meter, as Porstmann did. The latter held that there was no more reason to make the basic sheet one meter long than to make it one meter wide, in other words

[1] The weight of one gram per sheet with an area of one square meter is equivalent to a weight of about 1.1 pound per ream of 500 sheets of the same size.

that the third principle adopted by Ostwald contained an arbitrary element. If the basic sheet is given an area of one square meter, Porstmann reasoned, only one solution is possible, with the additional advantage concerning the specific weight referred to above.

The Ostwald system never became introduced into general practice. This was probably due, among other things, to the fact that it involved replacing the so-called "folio" size (210 x 330 mm)—used for a long time by the German government and other public authorities, and also for all kinds of official and semi-official documents—by a larger size sheet. Such a change would have meant an increase in cost and, moreover, would have prevented the further use of all existing folders, files, etc. The present A4 size (210 x 297 mm), being shorter than, and just as wide as, the old "folio" size, does not cause any difficulty in this respect.

To come back to earlier efforts made to systematize paper sizes, there also appears to have existed in France, around 1800, a system of paper sizes legally prescribed for certain official documents, which was similar to that developed by Porstmann. It is, therefore, almost certain that it was consciously developed on the basis of the same principles as adopted by the latter. However, in 1800 the time apparently was not ripe for a system of this kind to take root and it was forgotten until Porstmann rediscovered it.

Symbol	*Size in millimeters*	*Size in inches*
A 0	841 x 1189	33.11 x 46.81
A 1	594 x 841	23.39 x 33.11
A 2	420 x 594	16.54 x 23.39
A 3	297 x 420	11.69 x 16.54
A 4	210 x 297	8.27 x 11.69
A 5	148 x 210	5.83 x 8.27
A 6	105 x 148	4.13 x 5.83
A 7	74 x 105	2.91 x 4.13
A 8	52 x 74	2.05 x 2.91
A 9	37 x 52	1.46 x 2.05
A 10	26 x 37	1.02 x 1.46
A 11	18 x 26	0.71 x 1.02
A 12	13 x 18	0.51 x 0.71
A 13	9 x 13	0.35 x 0.51

Table 1

Main or A-series of paper sizes

Basing on the three principles stated above, the European main or A-series of paper sizes contains the sheets listed in Table 1. The basic sheet with an area of one square meter is designated by the symbol A0 (A zero); the next smaller sheet by A1; half of this by A2, etc. Therefore, the numerical index of

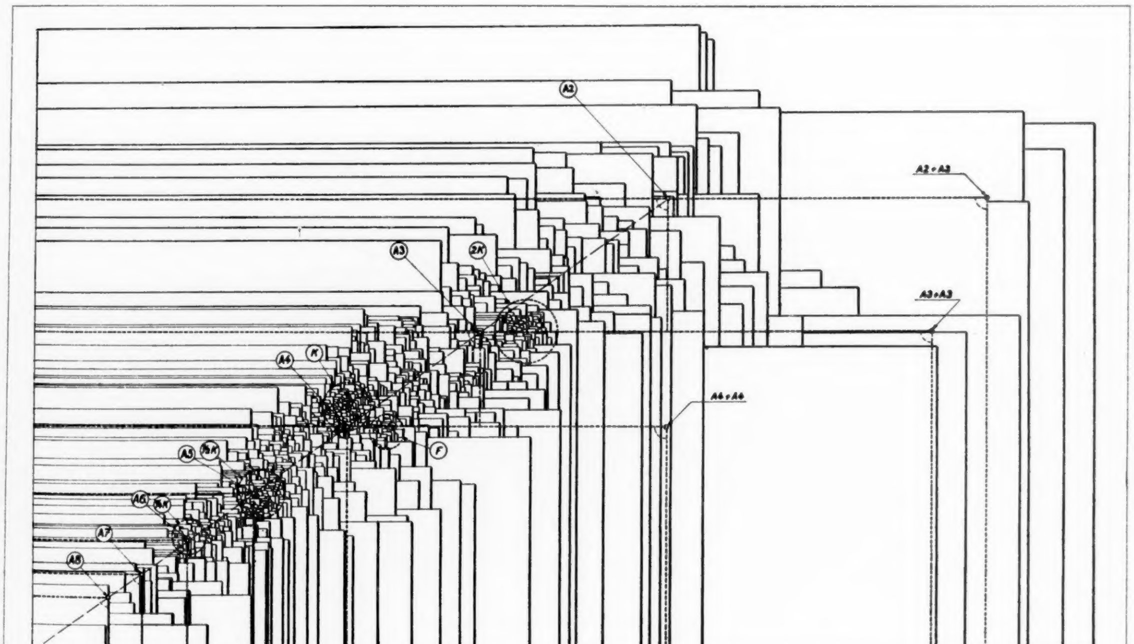

Figure 2

Composite picture of 950 sheet sizes which were replaced by 10 standard sizes

Calendar pads					A4	A5	A6	A7	A8	A9				
Address books					A4	A5								
Shares				A3	A4	A5								
Order blanks					A4	A5	A6							
Visiting cards							A6	A7	A8					
Business preprints				A3	A4	A5	A6	A7	A8	A9	A10	A11		
Letterheads					A4									
Memoranda						A5								
Pamphlets					A4	A5	A6	A7	A8					
Books					A4	A5	A6							
Time tables	A0	A1	A2	A3	A4	A5	A6	A7						
Telephone directories					A4	A5								
Business papers				A3	A4	A5	A6	A7						
Index cards					A4	A5	A6	A7						
Seals							A6	A7	A8	A9	A10	A11	A12	A13
Labels							A6	A7	A8	A9				
Maps	A0	A1	A2	A3	A4	A5	A6							
Patent drawings				A3	A4									
Posters	A0	A1	A2	A3	A4	A5								
Postcards							A6							
Price lists					A4	A5	A6	A7						
Bank checks							A6							
Signs	A0	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12	
Notebooks						A5	A6	A7						
Drawings	A0	A1	A2	A3	A4	A5	A6							
Magazines				A3	A4	A5	A6							
Newspapers		A1	A2	A3	A4	A5								

TABLE 2

Some applications of A-sizes

a specific A-sheet indicates how many times the basic sheet A0 must be halved to obtain the sheet under consideration.

In Table 2, applications of different A-sizes are listed, as given on a German national standard sheet. Special attention should be called to the widely used A4 size and to size A6. The latter was approved in 1925 by the International Postal Union—of which the United States is a member—as the size for an international postcard.[2]

Evidently, the A-series cannot cover all of the needs of the paper-using industries. For example, envelopes must be somewhat larger than the A-sheets which they are intended to contain in folded or unfolded condition, as the case may be. Also, there are cases where the difference between the sheet size required for a given purpose and either the next larger or the next smaller A-size is too great to be bridged.

In order to take care of such further requirements, the A-series has been supplemented by three other series respectively designated by the letters B, C, and D. These series have the following relationship to the A-series. Each B-size is the geometrical mean between two consecutive A-sizes. If, again, the geometrical means between the combined A- and B-sizes are determined, the new sizes thus ob-

Symbol	*Series A*	*Series B*	*Series C*	*Series D*
A 0	841 x 1189			
		707 x 1000	648 x 917	771 x 1090
A 1	594 x 841			
		500 x 707	458 x 648	545 x 771
A 2	420 x 594			

TABLE 3

Additional sizes between A0 and A2 dimensions in millimeters

[2] The area of the international postcard exceeds that of the official United States postcard by about 34 per cent.

tained may be divided into two series designated by C and D, respectively.[3] To illustrate this, the additional B-, C-, and D-sizes inserted between the sizes A0 and A2 are listed in Table 3.

All sizes belonging to either the B-, C-, or D-series are in accordance with Principle 1 (halving), while all of the sizes, independent of the series to which they belong, have the same shape (Principle 2).

Adherence to standard practice demands that sizes from the A-series shall be used if at all possible. If practical conditions do not permit this, sizes from the B-series should be used. If this also appears to be impossible, the C-series, and, as a last resort, the D-series should be used. Thus, for example, envelopes to take letterhead of the size A4 (210 x 297 mm), folded to the size A6 (105 x 148 mm), are made to the size C6 (114 x 162 mm).

Other additional sheet sizes, having a large ratio between length and width—such as may be required, for example, for drawings of ships, locomotives, or chimneys—may be obtained either by halving sheets belonging to the lettered series lengthwise, or by adding such sheets endwise with their small side. Evidently, the form of sheet as expressed by the width-to-length ratio $1 : \sqrt{2}$ is no longer conserved in such cases, but at least the dimensions of the sheets in question are either the same or multiples of those belonging to the lettered sizes. The "long" sheets may therefore easily be folded so as to permit of being stapled or bound with sheets of the lettered series, or of being put into standard envelopes, folders, or files.

In Germany, where the European system of paper sizes originated and where it has been worked out as a national standard in greater detail than has so far been done anywhere else, its introduction into practice has been very successful.

The public authorities in Germany—federal, state, municipal, and others—have strongly supported the introduction of the system. Mention may be made here of the measures taken in this respect by the German Departments of Commerce and Industry; of National Economy; of the Treasury; of Transportation; and of the Interior; by the Postmaster General; the Federal Railways; the Patent Office, etc. A large number of magazines have adopted the A4 size. A few years ago 24 technical magazines changed to the new size. The German Government Printing Office and many other printers use the new sizes exclusively, and it is claimed that there is no German printer who is not acquainted with the system. The letterhead size A4 has become common practice in commerce and industry. All wholesale dealers in paper carry in stock rough sheets intended for being cut to the standard sizes with a minimum

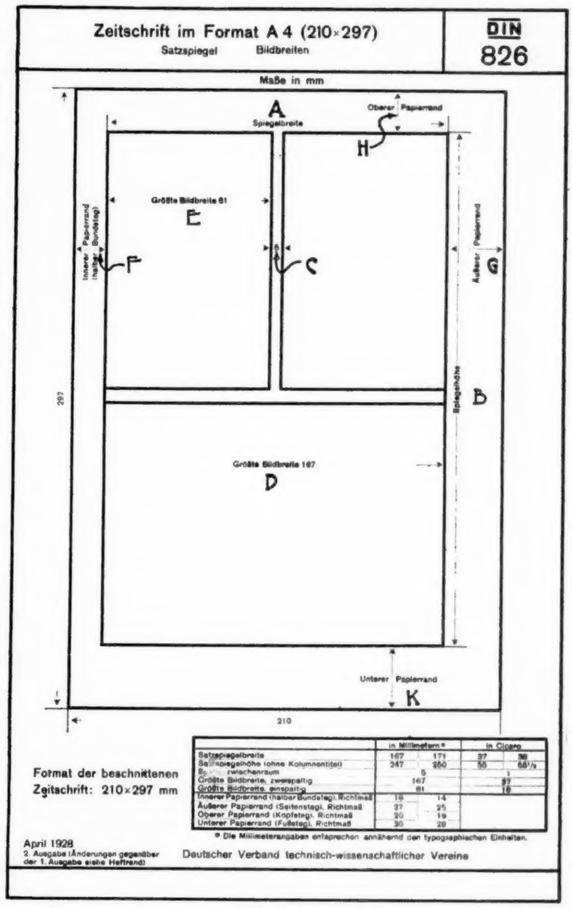

FIGURE 3

German standard sheet DIN 826 showing make-up of magazine page

amount of waste. The new system is generally used for technical drawings and for card index systems.

As a result of the general introduction of the standard paper sizes, all kinds of containers for paper products have been, or are being, standardized as to their general dimensions, thus becoming a commercial stock product with interchangeable dimensions. To realize what this means, one has to visualize only the fact that a single size of file drawer built in accordance with the new system will take in the same orderly manner letters, blueprints, magazine clippings, maps, filled-out business forms, patent drawings, etc. of the size A4, classified and filed in corresponding folders or binders.

In the other countries where the system has been adopted as a national standard, its introduction into

[3] For the sake of brevity, the mathematical development of the additional series is not given here.

practice also progresses constantly. A remarkable case of a change to the new system is illustrated by Figure 2. This shows the conglomerate picture of 950 sheet sizes originally used in an industrial organization in Czechoslovakia for different purposes: preprints, order blanks, drawings, etc. They were replaced by ten standard sizes in the new system, as follows: A2 to A8 inclusive, and three combined sizes: A2 + A3, A3 + A3, and A4 + A4, the latter three being oblong sizes obtained in the manner mentioned above. In Figure 2, the letter K is one of those indicating a region where a considerable number of old sizes were lying very close together. All of those in the neighborhood of K were apparently replaced by the size A4.

Among the many items involved in the standardization of paper sizes, only one will be dealt with here as an example showing how the European system has worked out. The make-up of a magazine page is given on the German standard DIN 826, reproduced in Figure 3.

The trimmed size of the magazine is A4, and detailed indications governing the make-up of the printed page, both with regard to text and illustrations, are given by the diagram on standard sheet DIN 826, in combination with the table given below the diagram. A translation of this table, with an added column of letters referring to the dimensions indicated in the diagram, is given in Table 4.

	Symbol	*in millimeters*		*in ciceros (1 cicero = 0.177 inch)*	
Width of printed space	A	167	171	37	38
Height of printed space (without titles above columns)	B	247	250		
Space between columns	C	5		1	
Largest width of cut (double column)	D	167		37	
Largest width of cut (single column)	E	81		18	
Inside margin (recommended) (half binding space)	F	16	14		
Outside margin (recommended)	G	27	25		
Top margin (recommended)	H	20	19		
Bottom margin (recommended)	K	30	28		

TABLE 4

Details for make-up of standard magazine page as given in the German Standard DIN 826, Figure 3

The adoption of standard widths for the printed space and the single column determines the standard widths of cuts, a question of special importance for advertisements. Cuts made for this purpose now can be uniform for all magazines, or one block may be used for several magazines.

A good deal of discussion has been raised by the question whether the standard sizes should apply to the rough or untrimmed sheets as supplied by the manufacturer and stocked by the wholesaler, or to the trimmed sheets, pamphlets, magazines, books, etc., made of the rough sheets, that is, to the final product.

The paper manufacturers and wholesale paper dealers have a primary interest in the sizes of the rough sheet, as these are directly related to the dimensions of the paper manufacturing equipment. What happens to the rough sheets later when they are cut up and trimmed is of no direct concern to these groups. A rough sheet can be subdivided in many ways into smaller sheets, and great freedom is consequently left in this respect to the user of the rough sheets. Adoption of standard sizes for rough sheets therefore does not necessarily lead to standard sizes of the final product. Moreover, a large variety of existing sizes of rough sheets which have grown up without any coordination—and, therefore, without one size being in principle better or worse than another—necessarily causes a selection

of standard rough sheet sizes to be an arbitrary one.

The users of paper, such as the printer, the business office, the drafting room, the library, are interested mainly, and sometimes exclusively, in the sizes of the final product, be this in form of loose trimmed sheets, or in form of stapled or bound printed matter. They have to write or print on this product; to file and to mail it; to assemble it into pamphlets, magazines, and books, etc. This problem directly controls the dimensioning of all objects intended to contain paper products, from a simple folder to an elaborate system of filing cabinets or the bookcases in a library. However, such a standardization of the rough sizes as will permit the paper user to obtain his trimmed sizes with the minimum amount of waste benefits him by a direct saving on the cost of the final product. Indirectly, such a solution also benefits the paper manufacturer and the wholesaler.

It is interesting to note that originally the Germans intended the basic sheet size A0 to be the size of a *rough* sheet. However, it appeared in practice that this led to a diversity in the sizes of the final product—through difference in methods of trimming—which was incompatible with the essential aim of the standardization, namely, uniformity of the final product to make it fit together in an orderly way. It was decided that the latter problem, arising daily in an innumerable number of cases all over the world, was far more important than the problems involved in the manufacture of paper, concentrated in relatively few places.

On these grounds, the Germans decided that paper size standardization should start from the sizes of the trimmed sheets or final product, the sizes of the rough sheets to be adapted to this condition. For practical reasons, they therefore adopted the lettered sizes as nominal sizes, a minus tolerance being given on the latter to make allowance for unavoidable inaccuracy.

As a rough sheet, the Germans have generally come to adopt in practice the size 610 x 860 mm (about 24 x 34 inches) from which the sizes of the main series, from A1 downward, may be cut with a minimum amount of waste. This holds good for the large majority of printing processes, even though the amount of trimming required is larger for some of these than for others. It is true that the rough sheet in question has an area which is about five per cent larger than one-half square meter—the standard basic sheet A1—but it has already become common practice in Germany to make a corresponding correction, based on this figure, in calculating the weight of the paper.

The above question has given rise to considerable discussion between the national standardizing bodies, 18 of which are federated in the International Standards Association (ISA) whose central office is in Basle, Switzerland. One of the purposes of the ISA being to eliminate discrepancies between national standards, if at all possible, the subject was discussed at an international conference held under ISA auspices in Paris during May, 1930. It appeared that among the countries which had adopted the standard paper sizes, Holland and Poland were the only ones definitely adhering to the "rough sheet size" standpoint. Among the other 16 member-bodies of the ISA that were represented, ten adhered to the German viewpoint, while the remainder for some reason or other formally did not take any side.[4] It was finally decided that each country should be left free to decide the question as it preferred, but it was recommended that the tolerances on the sizes and the amount of trimming should be kept as small as possible. Observance of this recommendation will bring the sizes of the final product automatically close together for all of the countries concerned, whatever their attitude in this respect may be.

Prospect of adoption by "inch" countries

How far the European system of paper sizes is likely to be adopted in the countries where the English system of measurement is most commonly used—more particularly the United States and Great Britain—is a question to be decided by the industries concerned in these respective countries. From the viewpoint of international uniformity in the tremendously developed exchange of written and printed matter between all nations of the world, the general adoption of a single system would evidently be highly desirable, benefiting the world at large by an incalculable economy in money and labor.

Without going more deeply into this question here, the writer believes that there is one practical point which should be mentioned briefly. Conversion of the metric dimensions into inch values (see Table 1) gives odd sizes which at first sight make the European system appear not very attractive to the interested groups in "inch" countries, and thus seem to create a handicap to its possible adoption. In this respect, it should be observed that the metric paper sizes were equally odd in comparison with the previously existing sizes in the metric countries, due to the introduction into the new system

[4] The American Standards Association is a member of the International Standards Association and was represented at the Paris conference, but its delegate did not express an opinion as the European standard paper sizes have not yet been given consideration in the United States.

of the value $\sqrt{2}$ or about 1.41. Actually, in the metric countries—where millimeter sizes ending in zero and 5 used to be favored—a new basic sheet size with dimensions 841 x 1189 mm was about as unusual as the equivalent size of 33.11 x 46.81 inch, or about 33⅛ x 46⅞ inch, would be in the United States. This matter seems therefore to be of minor importance, especially so as the adjustment of the paper manufacturing equipment, etc., to the new sizes would cause no more trouble than the adjustment to new round inch dimensions. That is, the natural difficulty in making the transition from the old to the new condition would lie in the change to the new sizes per se, and not in the oddness of the new sizes.

The success of the European system must no doubt be ascribed also to the fact that it covers all paper sizes, independent of the branch of industry in which they are used. Before its introduction, efforts had been made to systematize paper sizes in a restricted field, such as, for example, the sizes of technical drawings. For these, a special national standard was actually set up in Germany, only to be superseded by the present general system.

In this regard, it may be observed that no great benefit could be expected from partial attacks on the problem, however useful these might seem to be in their restricted field. In fact, there is so much interlocking between the different uses of paper that in the end only a general solution can be effective. Forms, drawings, bills, checks, pamphlets, and other data have to be mailed and filed with letters. A specific kind of paper may have to be used for any of these purposes and rough sheets must then be kept in stock without their ultimate destination always being known in advance. The sheets may have to be cut to letterhead, preprints, leaves for pamphlets, etc. How can a single rough sheet size take care of these different uses—while at the same time avoiding some waste of paper by excessive trimmings—unless the users have agreed on a common size of trimmed sheet in their respective branches?

Furthermore, any new system that is not based on, and completely determined by, a set of simple and obviously logical principles, has the inherent weakness of being unable to convince those inclined to adhere to the old sizes, of its merits. In fact, the sole strength of the old sizes lies in that they have been in use for a long time, and that many uses, each in a particular line, have become adjusted to them. If, under these conditions, an effort is made to weed out certain sizes in order to bring about simplification, each party will hold out for the conservation of its own preferred size. If the newly proposed system cannot rightly claim to possess certain advantages over the old, this is comprehensible. For example, if in the United States the problem is raised whether the letterhead size 8½ x 11 inches, or 8 x 10 inches, should be preferred, the question arises whether either of these sizes would fit more logically into a general scheme than the other.

This situation is not uncommon in standardization work, in cases where a selection is to be made from the existing. It should be realized, under such conditions, that it may be more beneficial to all groups concerned to adopt an entirely new standard than to make a compromise between the old systems. This has appeared to be true in Europe with regard to the paper size problem. The new system required every one who adopted it to change to some extent from what he had used so far, with consequent difficulties during the transition period. This has appeared to be well worth while, however, on account of the ultimate benefits derived in a lasting manner from the general unification.

The European development described above is particularly interesting because a situation similar to that existing on the Continent before the new system of paper sizes was introduced may be observed to exist in the United States. In spite of an effort made some years ago to reduce the variety of paper sizes by recommending the use of a selected series,[5] this country is still suffering from lack of fundamental unification in this field. Thus, for example, stock sizes lying as close together as 32 x 44 inches, and 35 x 44½ inches, both belong to the series recommended for general printing.

It seems, therefore, that the question of applying standardization to the American paper size problem might now well be given serious consideration by the American interests. Industry itself must solve this problem by getting together and discussing it from every angle. The American Standards Association (ASA) has for one of its main purposes to promote the development of national industrial standards by acting as a medium to bring the interests together and by lending its assistance, wherever desired by the technical experts, in accomplishing the task they have set themselves. ASA will, therefore, be glad to consider any request for having a national standard on paper sizes developed under its procedure, whether a request of this kind is submitted by a representative group, such as a trade association interested in the manufacture, the distribution, or the use of paper, or by a group primarily dealing with the machinery or equipment used in the paper industry.

[5] Simplified Practice Recommendation No. 22 on Paper, published in 1924 by the Department of Commerce.

Standards for the Economic Control of Quality for Manufactured Products

by
Fairfield E. Raymond,
Associate Professor of Industrial Research
Massachusetts Institute of Technology

Review of a book by Dr. W. A. Shewhart establishing a mathematical basis for quality control by random sampling

Industrial standards and quality control of manufactured products are inseparable. This fact is so widely recognized that it seems hardly worthy of any extended treatment until one stops to consider not only the means by which any standard is finally established, but also the cost involved in enforcing, through inspection, an accepted standard of quality. In evolving a standard the question invariably arises as to what should be adopted as the acceptable degree of precision to be used in evaluating the standard, from both the scientific or engineering viewpoint and the practical industrial viewpoint, and what should be the economic tolerance limits. In specifying quality, standards can all too easily be set to give so little latitude to the production men that the costs of manufacture and inspection quickly become prohibitive. On the other hand, any laxity in setting standards will mean defective or unsatisfactory products in the hands of the eventual customer, and will cause difficulties in assembling the products, since the component parts will not readily fit together or function in the manner prescribed by the original engineering requirements. Even if reasonable tolerance limits are established there is no assurance, because of the constantly varying conditions which are encountered in any manufacturing process, that either the component parts or the finished product will always meet the standard, unless there is maintained at all times an adequate system of inspection and control of quality. When the quantity of parts or products manufactured is large, the expense of inspecting each individually, not only in their finished form but also at critical operations in the process sequence, is again prohibitive. At some point between 100 per cent inspection and no inspection at all there should be a method for satisfactorily and economically controlling quality. Thus, as we shall see more fully, quality standards and quality control are mutually interdependent and a more complete knowledge of the basic conditions which underlie both is essential not only to the engineer but also to the industrial executive.

Dr. W. A. Shewhart of the Bell Telephone Laboratories, in his recent book *Economic Control of Quality of Manufactured Product,*[1] has evolved the necessary theory on which to base the practical technique for industry to use in establishing economic tolerances and methods of inspection. This book is an outstanding example of the tremendous benefits which industry can gain by the application of scientific and mathematical theories to the solution of the everyday problems of manufacturing management. In fact, Dr. Shewhart may be regarded as one of the pioneers in blazing the way toward a more exact knowledge of the behavior of the many factors, of an engineering, scientific, or economic and social origin, which industrial management must relate and employ. In this work he has shown that the final quality of a manufactured product is dependent upon two types of causes, which arise either from the manufacturing process, or from the state of the raw materials used; namely, assignable causes and chance causes. His whole theory depends upon the fact that when it is possible to detect and eliminate all assignable causes of quality variation, the quality of the final product can be assumed to be definitely within control. This condition can only exist when quality is under the sole influence of a constant system of chance causes, in which no one cause predominates and where the total effect of all of the chance causes, no matter which ones are present, will at no time exceed certain natural limits of quality variation.

The unique manner in which Dr. Shewhart has

[1] Published by D. Van Nostrand, Inc., 250 Fourth Avenue, New York, price $7.50. A copy may be borrowed by Sustaining-Members from the American Standards Association.

made use of mathematical and statistical technique is one of the significant features of the book, as it shows how such technique can be adapted to the needs of industry, and how it can, where necessary, be supplemented by experimental evidence to evolve a simple and practical procedure. This book should not be viewed merely as a text on theories of probabilities and statistics, but, rather, it should be considered for its value as an exposition and an enlargement on these theories, as they may apply to sampling, and in connection with their significance to the inspection function in management. His conception of a standard as a distribution function is most important, as is his use of accepted statistical tests in the detection of lack of control of quality. On the other hand, through the necessity of developing a theory of quality control, he is able to clarify certain issues in mathematical theory so that one may more easily distinguish between frequency distributions which follow either the normal or binomial law, and also more easily discriminate between functional and statistical relationships. Furthermore, he has collected and consolidated much valuable information with regard to the behavior of the statistics of a distribution function, whether the data be drawn from a normal or from a non-normal universe; as well as material in regard to the significance and reliability of the correlation coefficient and "chi-square" test in the detection of relationships. Much can be gained from an undercurrent of philosophy in this book concerning economy of measurement and the conditions and limitations under which a state of maximum control can be assumed.

In fact, the conclusions presented in this study are of so much significance to those who have anything to do with the evolution of standards that the reviewer believes a somewhat extended consideration of them in this regard is well worth while. First of all, it is important to note that in order to establish a basis for determining when quality is controlled Dr. Shewhart utilizes frequency diagrams to depict the characteristic or typical distribution of quality as it comes from a given manufacturing process for which there exists a certain standard of quality, and he then employs the theory of statistics to evaluate the natural limits set by the constant system of chance causes as economic tolerances for the quality standard. He next proceeds to develop quality control charts for which the ordinates are the scale of measurement of quality and the abscissa are either a scale of time or the numerical order in which successive samples are taken. Upon this chart are drawn the predetermined economic tolerance limits, and then the average run of quality of the product is plotted as obtained from inspection records. Thus, as long as any points fall outside of the tolerance limits it is taken as an indication that assignable causes of quality variation are still present and that work must be done to eliminate them before quality may be considered as controlled. Therefore, the author proceeds to show that once the manufacture of a product is brought within control complete inspection can be dispensed with and the economies of sample inspection can eventually be realized. In justifying this conclusion the theory of probabilities and statistical methods again plays an important part.

In making any practical application of this simple plan for the control of quality, in order to distinguish between quality variations arising from assignable or chance causes, one must have some means of predicting to what extent the actual run of quality from manufacturing processes naturally varies from the established standard. This necessitates the recognition of some objective quality, such as physical characteristics or dimensions of the product, in contrast to subjective qualities based on human wants, so that one can obtain not only quantitative information as to the run of quality but also a causal explanation of the observed phenomenon which determines the conditions affecting quality. Therefore, if one is to gain, from an interpretation of the past, a reliable indication of the future run of quality, one must examine the underlying causes in the following manner. First, one must note the differences in quality of a number of things of the same kind, and whether the quality can be left to chance. Second, if this be the case, one must discover the distribution of the qualities obtained in the long run and the nature of the "chance cause system." Third, one must determine, whether or not, if the surrounding conditions are apparently different, the underlying system of chance causes remains essentially the same. Fourth, one must be able to detect causal relationships. Prediction in this case, Dr. Shewhart shows, depends upon the fact that the law of large numbers holds true and that there is sufficient evidence of the existence of systems of chance causes in nature. Accordingly, if quality is to be controlled economically one must ascertain what constitutes the state of maximum control, and what the chances are that this condition can be frequently approximated in practice, and whether quality fluctuations between samples will fall naturally within certain limits when influenced only by a constant system of chance causes.

Dr. Shewhart concludes that for all practical purposes a state of maximum control can be defined as the condition reached when chance fluctuations

in a phenomenon are produced by a constant system of a large number of chance causes in which no cause produces a predominating effect. Hence, even though there exist many functions for expressing quality distributions, for which no single characteristic can itself be taken as indicative of maximum control for the observed distribution it represents, there is good reason to believe that maximum control has been reached when the distribution exhibits normality provided conditions of control apply. Experience shows that after assignable causes have been found and eliminated the observed distribution is usually smooth and unimodal and sufficiently near normal to be fitted by the first two terms of the Gram-Charlier series. Hence, by resorting to fundamentals supplied by the theory of statistics as to the natural grouping of data when the law of large numbers holds and assignable causes of variation have been eliminated, means are provided for establishing what may be termed a tolerance range for a given quality characteristic which has a marked significance in the evolution of practical manufacturing standards.

Problems of sampling

Since manufacturing processes may be continued over long periods of time, involving the production of hundreds of thousands of pieces per year, and since it is impossible and undesirable to await the termination of the process before evaluating quality, it is necessary to draw samples from the process or manufacturing lot at intervals and, having inspected these individually for their quality characteristics, determine to what extent quality is still within control. This raises the question as to what assurance one has that the distribution of quality within any one of these samples will approximate the normal distribution of quality for all pieces being produced, even under controlled conditions, to make it possible to determine from these samples alone whether the indicated quality is representative of that for the entire process lot and that the run of quality lies within the established tolerance range. Here again Dr. Shewhart has employed the theory of probability, as it may relate to several samples, to produce evidence that within reason, if the sample is of sufficient size and bears a proper relation to other samples and the total process lot, the observed distribution of quality for the sample and the actual quality distribution for the process lot will not differ appreciably, and any discernible variation beyond the tolerance limits is an indication of the presence of assignable causes and a state of lack of control. This can be accomplished theoretically by comparing certain significant statistics for the quality distribution in the sample with similar statistics for the distribution of quality for the process or lot, as the statistics of a distribution provide a well-recognized means of measuring the relationship of two distribution functions. It must be recognized, however, that the best that ever can be obtained in practice will only be an estimate of these statistics for the theoretical distribution of quality for the total number of pieces produced. Nevertheless, sufficient evidence has been brought forth to justify the acceptance of the average and the standard deviation as statistics containing the greatest amount of total information concerning the theoretical distribution, which can legitimately be employed as measures of such relationship in preference to other statistics of a distribution.

Naturally, in the evolution of a fundamentally sound theory for treating sample fluctuations Dr. Shewhart recognizes that there exist certain essential limitations dependent upon the basic assumptions necessary to the solution of such a problem which prohibit an exhaustive mathematical treatment of this phase of the subject. Nevertheless, he has been able to accumulate sufficient theoretical evidence, supplemented by experimental results, to demonstrate that under industrial conditions symmetrical limits can be established for controlling sampling fluctuations. Accordingly, appropriate methods can then be evolved for conducting periodic sample inspection of quality, provided that in specifying the standard of quality the above two characteristic statistics of the distribution be included as measures of allowable sampling fluctuation.

The problem of establishing tolerance limits for over-all quality becomes complicated when many piece parts or a variety of apparatus must be assembled to form the finished product. It is inconceivable that the tolerance range for the product should be so constituted as to represent the summation of tolerance ranges for the quality of each component part, as there is only a remote possibility that all these parts will have, throughout, a quality lying wholly at either the upper or lower extremes of their respective tolerance ranges. However, if the distribution of the summation of the quality for the parts assembled into the product can be determined and tolerance limits set on the characteristic statistics of this distribution, a more reliable tolerance range can be established which will impose much closer limits on the desired standard, as there is but a slight probability that the extreme cases will ever be more than occasionally encountered. Furthermore, when the final quality of an assembled product is composed of many qual-

ity characteristics the tolerance limits can still be determined through statistical theory. As a result, Dr. Shewhart concludes that the specification of quality for control purposes, at least, should include the specification not only of the quality characteristic itself but also the two statistics of the quality distributions; namely, the average and standard deviation.

The meaning of standard

In conceiving of a quality standard these facts alter considerably the usual thought that a standard is either a specific value or a range of values. Instead, Dr. Shewhart views standard qaulity as a distribution function representing what one can actually hope to obtain in arriving at a standard quality. Accordingly, he raises the question of how far one should go in specifying the distribution function to be used as standard. In general, he concludes that under certain conditions specifications of the following types can be used; namely, the probability of the production of a defective piece of product can be expressed first in terms of the number of defective pieces in the lot; second, in terms of the expected or average quality alone; third, in terms of both the average quality and the standard deviation; and fourth, in terms of the average, standard deviation, and the skewness and flatness of the distribution of the particular quality characteristic in question. Of these, the third specification is of most value and the first will be of value in catching erratic trouble. Little value can be gained from the other types of specification, particularly the fourth, since its evaluation depends upon the distribution function itself and that is seldom known.

Since standard quality can be viewed better as a distribution function and statistics of the distribution can be employed as a measure of its characteristics, Dr. Shewhart then proceeds to determine which statistics provide the most efficient method of detecting the presence of assignable causes or whether an observed sample is not influenced solely by a constant system of chance causes. Efficiency in measuring and limiting a standard is obviously of great importance. Dr. Shewhart concludes again that of all the available statistics for detecting changes in central tendency, dispersion, and relationship the average quality, standard deviation, and correlation coefficient, respectively, are the best. Similarly he shows that the first two are also the best for detecting changes in universe effects; that is, the characteristics of the distribution function itself. Dr. Shewhart then proceeds to justify the choice of symmetrical limits for these statistical measures of quality standard, drawing his precedents from mathematical and statistical theories, with the result that for a given sample size there are corresponding limits expressible as some multiple of the standard deviation for either the universe of effects or the estimate of the statistic in measuring sampling fluctuations. He then arbitrarily selects a multiple of three because in practice it has proved to be economical and includes 99.7 per cent of all possible values. It would have been desirable at this point if Dr. Shewhart could have explained more fully the philosophy which underlies his choice of these economic limits, or if he could have supplemented his statements with experimental evidence to show that in the long run these limits make possible the reduction of the costs of inspection to a minimum, as this is a most important consideration for all operating industrial executives.

In addition to these methods of detecting lack of control in respect to an accepted standard of distribution five criteria are proposed for detecting lack of constancy in the unknown cause system by making use of certain well-established tests commonly employed in statistics. For each criterion control limits are established on the same basis as described above, the choice of the most appropriate criteria depending upon the source and nature of the data and the type of cause which is most likely to interfere with the normal condition under which quality remains within control.

The maintenance of quality standards in products is of utmost importance to any manufacturing enterprise if it is to retain the goodwill of its customers. Inspection naturally safeguards the consumer from receiving a product of poorer quality than he specified, nevetheless the cost of 100 per cent inspection may be prohibitive or impossible due to the necessity of testing each item to destruction. Dr. Shewhart brings out most decidedly the advantage to be gained through quality control and the methods of sample inspection which he has proposed because they provide, economically, means for protecting the consumer from accepting a bad lot of product. On the assumption that the consumer is willing to accept in the long run a small number of defective pieces per shipment, termed the tolerance, and expressed as some fraction of the total shipment, the acceptance of the whole shipment can be determined by sample inspection, provided that the sample inspected will not contain more than the acceptance number of defective pieces. This is justifiable on the grounds that the probability is small that the consumer will in the long run have to accept a shipment which contains more defective units than are contained in the tolerance lot. This probability

is termed the consumer's risk. In sampling, the acceptance number is predetermined, and is recognized as the number of defective pieces contained in a sample of given size, which if exceeded will indicate that the lot as a whole does not meet the specifications and requires complete inspection before final acceptance or rejection. It should take only a little study for an executive to realize the benefits which can be obtained through scientific methods of quality control when they have such a direct application to the maintenance of quality standards for his manufactured products.

Quality control in practice

Professor Shewhart devotes the remainder of the book to a discussion of quality control in practice. In the first place he points out that in the development of industrial standards and a system of quality control any such program should commence with the study of the results of research to provide a basis for design, followed by the construction of a laboratory or ideal engineering model from which tool-made samples can be produced and tested to provide the data for establishing specifications of standard quality for commercial and manufacturing purposes and laying out the production methods. Each step then in this program should be carefully scrutinized for the presence of assignable causes of variation, as only through their detection and elimination can satisfactory quality standards be evolved and quality control achieved. In addition, he states that the statistical methods employed in quality control can also be employed to predict the probable life history of a product during its period of actual service. In the second place he emphasizes the significance of measurement in quality control which is naturally essential to the maintenance of and adherence to standards of quality, with special reference to the minimizing of the cost of measurement, the economical number of measurements, and the propagation of error in measurement. In the third place he stresses the necessity of actually carrying on a scheme of sample inspection for maintaining continuously a condition of control if one is to predict the average run of quality for the entire lot in process from periodic sampling during production, and the ability to adhere to quality standards. Furthermore, he points out that care must be taken to obtain random samples for inspection purposes and that the size of the sample must be such as to insure that the law of large numbers will hold. In the fourth and last place he describes the ideal procedure for a quality control program for industry and the advantage gained from carefully prepared quality reports.

The more familiar one becomes with Dr. Shewhart's concept of standards of quality and theories of quality control the more one is impressed with the fact that there exists a much broader field in industrial management and engineering and even science in general for the application of his principles and technique, which were originally evolved for quality control alone. The fact is that practically everything management deals with, except where the determination of quantity is the sole objective, has certain characteristics or attributes which lend themselves to a form of measurement and control identical to that proposed by Dr. Shewhart for the control of quality, which in the end will be required if ever the over-all efficiency of management is to be evaluated. His discussion of the behavior of phenomena, as to whether or not they follow some exact, statistical, or empirical law, is of great significance to management, as underneath all this there lies a philosophy the full extent and value of which has yet to be revealed. Management in all its aspects has long been considered as an inexact science because its chief purpose is the relating of scientific and engineering principles to economic and human factors. This process introduces certain supposedly indeterminate factors, the behavior of which no exact law of nature can accurately predict. Nevertheless, as these problems are studied more closely there seem to be statistical laws, which can be applied in many cases in a manner similar to that for quality of a manufactured product, to explain or to assist in predicting the normal conditions, which then can be recognized as a standard for that particular function in management, whether it be large or small.

There also exists a wide field for Dr. Shewhart's theories in the enlargement of our general philosophy of measurement with special regard to precision and economy of measurement, recognizing that much has already been done along these lines. Here again the whole process of evolving standards has much to benefit by in the long run.

Finally, it is well to point out a very close connection between Dr. Shewhart's theories and the well-recognized principle of "management by exception." This law states that managerial efficiency is greatly increased by concentrating managerial attention solely upon those executive matters which are variations from routine, plan, or standard, which means that an industrial executive should only concentrate upon those situations in business which give evidence of lack of control through the indication of assignable causes of variation. Thus, if each

function of management, whether of an engineering or operating nature, be studied in the light of Dr. Shewhart's theories, standards of performance can be established in accordance with the normal distribution of each characteristic of the function when influenced solely by a constant system of chance causes. Thus, only when actual performance exceeds in some manner the established control limits need an executive pay specific attention to this function under his supervision in order to detect and eliminate the assignable causes of variation which have crept in. Out of all this one can finally arrive at a new concept of efficiency in management in which standardization plays an important part, because in the end, if we can conceive of efficiency in this case as the economic control of quality characteristics or attributes of management as a whole, we have a means for directly measuring management.

Foreign Standards Available from ASA

The following are new foreign standards available to Sustaining-Members for loan or purchase through the ASA office. They are available in the language of the country under which they are listed. In requesting copies of the standards it is necessary to list only the ASA serial numbers preceding the titles. Send either a post-card or a note containing only the name and address of the person wishing to receive the standards, and the numbers of the standards desired. The card or envelope should be addressed to the American Standards Association, 29 West 39 Street, New York.

ASA Serial Number — *Norway*

168. Bollards
169. Eye-bolts
170. Eye-nuts
171. Fastening of milling cutters for dressing boards
172. Plugs, ¼ in. to 4 in., pipe
173. Countersunk rivets
174. Round head boiler rivets
175. Round head rivets for structural purposes
176. Tongued, grooved and V-jointed, and tongued and grooved and beaded boards
177. Tongued, grooved and V-jointed, 2-sides, and tongued, grooved and beaded 2-sides, boards
178. Tongued and grooved, and double-tongued and grooved boards

Bureau of Standards Issues 1932 Year Book

The 1932 edition of the *Standards Yearbook* has been issued by the National Bureau of Standards as Miscellaneous Publication No. 133, and may be purchased from the Superintendent of Documents, Government Printing Office, Washington, D. C., at one dollar per copy, or through the office of the American Standards Association.

The special feature of the present *Yearbook* is a series of articles contributed by experts in numerous fields of communication. These cover such diverse subjects as radio, aeronautical communication, television, acoustics, traffic signals, and language.

The book reviews the work of the National Bureau of Standards and of the national laboratories in other countries; the work of a number of international standardizing agencies, such as the International Bureau of Weights and Measures, the International Union of Geodesy and Geophysics, the International Electrotechnical Commission, the Pan American Sanitary Bureau, and the International Standards Association; and the standardization activities of the 21 national standardizing bodies. It also includes a complete list of technical societies and trade associations, together with brief reviews of their standardization activities. There is also a valuable chapter on state, county, and municipal purchasing agencies.

The bibliography on standardization prepared by the Library of Congress, which in previous editions has been a part of the *Yearbook*, has been published as a separate document this year, and may be purchased for five cents per copy.

Death of Luther D. Burlingame

Luther D. Burlingame, industrial superintendent of the Brown & Sharpe Manufacturing Company, Providence, R. I., who was actively interested in the work of the American Standards Association, died on June 2, at the age of 76.

Mr. Burlingame was the representative of the American Society of Mechanical Engineers on the Sectional Committee on Standardization and Unification of Screw Threads (B1), and represented the Small Tools Group on the Sectional Committee on Allowances and Tolerances for Cylindrical Parts and Limit Gages (B4). He was chairman of the original sectional committee on Standardization and Unification of Screw Threads which was organized in 1920.

Sectional Committees on Test Methods Submit Annual Reports[1]

Year's activities of committees on wrought-iron and wrought-steel pipe and tubing and classification of coals

Wrought-Iron and Wrought-Steel Pipe and Tubing[2]

This report of the Sectional Committee on Standardization of Wrought-Iron and Wrought-Steel Pipe and Tubing[3] is one of progress only. A preliminary draft of the standard entitled "Proposed Tentative American Standard for Wrought-Iron and Wrought-Steel Pipe for Service at Maximum Temperature of 450 F" has been prepared. This proposed tentative standard is developed to cover the entire field of piping work for wrought-iron and wrought-steel pipe from the lowest pressure requiring the use of thin-walled pipe in the larger sizes to pipe sufficiently heavy for the highest pressures now in use, namely, that for 1,500 lb and in all sizes from 1/8 to 24 in. in nominal outside diameter with the addition of the 30-in. nominal size for thin-walled pipe. Comparison with standard schedules now in use shows that the set-up provides for standard weight pipe, 1/8 to 12 in. in nominal size and extra-strong pipe, 1/8 to 10 in. in nominal size. The need for double-extra-strong pipe as now manufactured was not apparent.

Reports received on the preliminary draft of the specifications from members of Subcommittee 2 on Pipe and Tubing for Low-Temperature Service and Subcommittee 3 on Pipe and Tubing for High-Temperature Service indicated that the general form and arrangement were satisfactory. It is hoped that the proposed standard can be in shape for general comment of industry and the approval by the sectional committee at an early date.

Subcommittee 3 on Pipe and Tubing for High-Temperature Service has been requested to revise Table 1 in the Standard Specifications for Lap-Welded and Seamless Steel Pipe for High-Temperature Service (A.S.T.M. Designation: A 106) of the American Society for Testing Materials to line up to best advantage with present mill practice. When available, the revised table will accompany a revision of the Standard Specifications A 106 now under consideration by Committee A-1 on Steel of the American Society for Testing Materials. The revised table will include a wall thickness schedule for 300-lb seamless steel pipe and, in general, will conform to the standards being formulated in this sectional committee.

A progress report has been received from Subcommittee XXII on Valves, Fittings, Piping, and Flanges for High-Temperature Service of the A. S. T. M. Committee A-1 on Steel regarding the feasibility of drafting specifications and setting values of allowable stress for materials used at temperatures above 750 F. Subcommittee XXII proposes to draft specifications and set allowable stresses for materials suitable for use at temperatures up to 850 F. Allowable stress at 850 F will be taken as a percentage of that previously established for use at 750 F, the percentage for any particular metal being determined from consideration of its long-time creep characteristics. A curve of suggested percentages covering a range of temperatures was included in the report by way of illustrating the set-up.

Classification of Coals[4]

During the past year the Sectional Committee on Classification of Coals,[5] functioning under the procedure of the American Standards Association, has continued to collect and correlate facts and data on

[1] These reports were presented at the Annual Meeting of the American Society for Testing Materials at Atlantic City, N. J., June 20-24, 1932. The A.S.T.M. is sponsor for the projects.

[2] Submitted by H. H. Morgan, district manager, Robert W. Hunt Company, Chicago, Ill., chairman of the sectional committee. Sabin Crocker, designing engineer, Detroit Edison Company, Detroit, Mich., is secretary of the committee.

[3] ASA project number B36.

[4] Submitted by A. C. Fieldner, chief engineer, Experiment Stations, U. S. Bureau of Mines, Washington, D. C., chairman of the sectional committee. C. B. Huntress, executive secretary, National Coal Association, Washington, D. C., is secretary of the committee.

[5] ASA project number M20.

the composition, properties, and uses of North American coals. Thirteen papers giving results of some of this work were presented and discussed at the third Symposium on the Classification of Coal held at the February, 1932, meeting of the American Institute of Mining and Metallurgical Engineers. These papers and the discussions will be published in the 1932 *Transactions* of the Coal Division of the Institute. Aside from the immediate subject of coal classification these papers contain a wealth of valuable information on coal technology. The foreign point of view on classification has been presented by English and German technologists in several papers(1, 2, 3, 4)[6] read and discussed at the Third International Conference on Bituminous Coal held at Pittsburgh, November, 1931. A review of the work of the sectional committee was presented by H. J. Rose(5), chairman of the Technical Committee on Scientific Classification of Coal. The presentation of these papers and the ensuing discussion at these two conferences have aided greatly in clarifying the complex problem of coal classification.

Intimate contact with the Associate Committee on Coal Classification of the National Research Council of Canada has been continued with mutual profit. Representatives of the Canadian committee have attended all meetings of the sectional committee. The chairman of this committee attended the Montreal meeting of the Canadian committee on April 4, 1932. The Mines Department and the National Research Council of Canada and the Research Council of Alberta have been particularly active in making surveys of the properties of Nova Scotia and Alberta coals, the latter being important because of the range in rank from lignite to bituminous coal. An informative review of the composition and classification of Canadian coal was presented by Stansfield(6) at the Fuel and Coal Symposium held in October and November, 1931, at McGill University, Montreal.

The sectional and technical committees held two group meetings during the past year, one in Pittsburgh on November 19, 1931, and the other in New York City on February 16, 1932. At the February meeting all the officers of the sectional and technical committees were re-elected for two years, and a vacancy in the Executive Committee was filled by the election of W. H. Fulweiler.[7] The work of the three technical committees during the past year is described below.

Technical Committee on Marketing Practice (F. R. Wadleigh,[8] chairman).—This committee did not hold any separate meetings but met with the other committees and advised on marketing practice.

Technical Committee on Use Classification (W. H. Fulweiler, chairman).—This committee in cooperation with the Fuel Committee of the National Association of Purchasing Agents sent out questionnaires on grades and classes of coal used in steam generating plants, and on factors affecting the use of coal with different types of stokers and furnaces. A progress report on the results of this questionnaire was submitted at the November meeting of the committee. Another subcommittee, headed by A. H. Willett of the National Coal Association, circularized all the cities in the United States, 93 in number, having a population in excess of 100,000, with reference to provisions in smoke abatement ordinances relating to differences in kind or quality of fuel. The replies received, together with a recently published digest(7) of smoke ordinances, have furnished data needed by the committee for establishing a division line between the so-called "smokeless" or low-volatile coal and medium-volatile coal. The collection of data on the requirements of coal for various uses was continued and reports were completed on coals used in the Portland cement(8), ceramic(9), and non-ferrous metallurgical(10) industries.

Technical Committee on Scientific Classification (H. J. Rose,[9] chairman).—This technical committee has been very active through the work of its various subcommittees.

Subcommittee 1 on Nature, Location, and Mode of Occurrence was instrumental in stimulating much needed work by various organizations in filling in gaps where physical and chemical data were lacking. The U. S. Bureau of Mines in cooperation with the Anthracite Institute is making a survey of the chemical and physical properties of Pennsylvania anthracite. A similar survey of all the mines in the State of Washington was completed by the Bureau and published(11, 12). This survey, which included all ranks of coal from lignite to anthracite, was of particular value in showing the relative merits of various chemical and physical criteria, such as moisture, Btu, fixed carbon, friability, and slacking properties for the classification of coal(13). Similar data are being obtained in surveys of Canadian coal fields by the Mines Department and Research Council of Canada. The U. S. Geological Survey has completed a survey of Arkansas coals(14) which fills in one of the existing gaps in the twilight

[6] The numbers in parentheses refer to the reports and papers given in the list of references appearing at the end of this report, see p. 218.

[7] United Gas Improvement Company, Philadelphia, Pa.

[8] Washington, D. C.

[9] Director, General Laboratory Department, Koppers Research Corporation, Pittsburgh, Pa.

zone between anthracite and bituminous coals. Considerable data have been published in recent years on the friability of coals from Canada(15, 16), Washington(11, 12), Illinois(17, 18), and West Virginia(19). Similar work is in progress on Pennsylvania anthracite and bituminous coal.

Subcommittee II on Methods of Analysis, Origin, and Composition of Coal has continued to review the methods used in coal analysis and their application to the classification of coal. The need for standardization of methods for determining the friability of coal has been recognized by Committee D-5 on Coal and Coke of the American Society for Testing Materials by the appointment of a subcommittee for standardizing such a method under the chairmanship of R. E. Gilmore of the Department of Mines, Canada. Friability tests thus far reported by various workers indicate a rough relationship between friability and rank of coal. Low-volatile bituminous coals usually were found to be much more friable than either medium-volatile coals or anthracites.

The U. S. Bureau of Mines' study(13) of the slacking properties of coals from Washington and other states has been completed on a series of coals of various ranks ranging from lignite to anthracite. It appears from these results that the first cycle slacking index may serve as a means of differentiating between sub-bituminous and bituminous coals. Almost all of the United States coals thus far tested which showed more than 12,000 Btu on "as mined, ash-free" basis were found to have a slacking index of less than 5 (non-slacking class). At approximately this point in the Btu scale of rank, the slacking index began to rise above 5. Similar studies on Canadian coals are being conducted by the Associate Committee on Coal Classification, and in addition the alkali-soluble ulmins(20) in coal are being studied with particular reference to subdivision into classes of the lower ranks of coal.

As pointed out by Rose(5), most systems for the scientific classification of coal are based on analyses calculated to the dry (105 C) basis, and this basis admittedly has advantages when comparing coals of similar or high rank. However, the committee has come to the conclusion that when devising a classification to include coals of all ranks, a basis including normal moisture content of the coal as it occurs in the bed is not only desirable but necessary. This is a conclusion which has long been held by geologists and others who have had an opportunity to become familiar with the properties of low-rank coals.

If then, it is decided to classify coals on a moist basis, it will be necessary to have a method for determining the true inherent moisture in such samples which may have additional adventitious moisture or which may have lost some of the true moisture by evaporation. The Associate Committee of Canada has given special attention to this problem, and Stansfield and Gilbart(21) have developed a method involving the exposure of samples to atmospheres of increasing humidities up to nearly 100 per cent. By plotting the moisture retained in the coal against the relative humidity and extrapolating the curves to 100 per cent humidity, the true moisture is read off at the point where the curve intersects the 100 per cent humidity coordinate. While this method requires further study, it promises to afford a means of determining the true moisture where the ordinary mine-sample is suspected of not showing the true moisture. The whole subject of the condition of water in coals of various ranks has been reviewed by Gauger(22) and further studies along this line are being conducted by him at the Mineral Industries Experiment Station of Pennsylvania State College.

Further studies have been made of the use of formulas for computing the mineral matter in coal from the ash(23). The Parr formula for determining "unit coal" gives slightly better results in correcting for both ash and sulfur than any other formula tested by the subcommittee. However, this formula, as well as others, is based on averages and does not apply closely to some individual coals, especially those which are high in both pyrite and carbonates. In such cases it seems best to reject the bulk of the impurities by crushing the coal and then floating it on a heavy-gravity liquid before making the analysis. In testing the accuracy of various formulas against the Stansfield and Sutherland "fractionation method"(24) data have been obtained on certain approximate formulas, such as, mineral matter = 1.1 ash, and mineral matter = 1⅛ ash. These formulas are much simpler to calculate, and the results are surprisingly close to those given by the Parr formula on low-sulfur coals.

Comprehensive studies of the constitution of a series of American coals in relation to their carbonizing properties have been conducted throughout the entire year by the U. S. Bureau of Mines in cooperation with the American Gas Association, and a number of reports have been published(25, 26, 27, 28). This investigation includes a systematic examination of the chemical and physical properties of the coal, the microstructure of a columnar section of the coal bed, and the yields and properties of the coke and by-products resulting from carbonization at various temperatures ranging from 500 to 1100 C. The Mines Branch of the Department of Mines of Canada also has studied the carbonizing prop-

erties of a number of coals and has published(29) a system of classifying coals for use in the by-product coking industry. In this system the percentage of volatile matter is plotted against the "specific volatile index." The "specific volatile index" is computed by the following formula:

$$\text{Specific volatile index} = \frac{\text{determined Btu of coal} - (\text{per cent fixed carbon} \times 14{,}500)}{\text{per cent volatile matter}}$$

By this method of plotting, coals of various ranks fall in an approximate straight line with lignites on one end and anthracite on the other. Further study of this scheme may show that it has certain advantages for the scientific as well as the use classification of coal.

Subcommittee IV on Tentative Classification of Coals has continued the plotting of some 10,000 analyses of American coals on the multibasic coal charts. These charts consist of graphs for the various districts and beds, in which the percentage of fixed carbon is plotted against the Btu of the ash-free, as-mined coal. Other important properties such as slacking index, friability, coking index, etc., are indicated on the graphs in order to furnish a picture of how the various coals may best be grouped into classes. A progress report(30) and a general review of the present status of scientific classification of American coals was presented at the symposium held in New York in February.

In conclusion, it may be said that the fact-finding period which of necessity preceded the actual work of classification is now drawing to a close. Further laboratory work is of course necessary, but the data now on hand are sufficient to proceed with the selection of the criteria for the various classes according to the rank of the coal. It is expected that a tentative classification by rank will be submitted for consideration by the Technical Committee on Scientific Classification at the fall meeting, and by next year it is hoped that the committee will report the approval of several phases of the work on coal classification.

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Standards on Wires and Cables Approved by ASA

Three standards for wires and cables were approved by the American Standards Association on May 21 as follows:

American Standard Definitions and General Standards for Wires and Cables (C8a-1932)

American Tentative Standard Specifications for Weatherproof (Weather-Resisting) Wires and Cables (C8k1-1932)

American Tentative Standard Specifications for Heat-Resisting Wires and Cables (C8k2-1932)

The first of these, the definitions and general standards for wires and cables, include definitions and standards of general character which are applicable to wires and cables for power purposes and comprise a rearrangement of the American Institute of Electrical Engineers' standard number 30 of October, 1928, which has been brought up to date with certain additions and the deletion of some of the tabular matter. The standard contains definitions for the various types of wires and cables, conductivity standards, designation standards, high voltage test standards, insulation resistance standards, capacitance or electrostatic capacity standards, and maximum temperature limits.

The Specifications for Weatherproof (Weather-Resisting) Wires and Cables (C8k1-1932) cover weatherproof wiring and cables and the materials used for coverings and saturating compounds as applied to metallic conductors. The specifications are divided into the following headings: covering; saturating compound, which includes the tests therefor; stranded cables, which includes sizes of conductors

and the stranding therefor; standard weights; a table of weights and weatherproof wires and cables; samples for tests; tests on copper conductors; and explanatory notes.

The Specifications for Heat-Resisting Wires and Cables (C8k2-1932) cover the usual type of heat-resisting covering commonly known as "slow-burning" as applied to metallic conductors for use in hot, dry locations where the other types of insulation would not long endure or where the presence of large masses of inflammable materials would be objectionable. As explained in the standard itself, "There are many types of heat resisting materials used for insulating electrical conductors, but no attempt is made in this specification to cover anything but the so-called 'slow burning' insulation. The various types of asbestos coverings and enamels are for special purposes and are generally put out under trade names."

The following subjects are included in this standard: number of grades; material and workmanship; thickness; adhesion; samples for test; and explanatory note.

It is expected that printed copies of these documents on wires and cables will be available in the near future.

ASA Approves Radio Standards

Two standards for radio have been approved by the American Standards Association. The first of these, covering standard vacuum tube base and socket dimensions (C16c-1932) is an extension of Specifications for Vacuum Tube Bases (C16c1-1929). The Specifications for Vacuum Tube Bases covered only dimensions of standard four-pin vacuum tube bases of the large and small type, while the new standard covers in addition the following: dimensions of large four-pin base without bayonet pin; large five-pin base without bayonet pin; large five-pin base; terminal caps for receiving tubes and transmitting tubes; four-pin transmitting tube base; large transmitting tube base; terminal cap with large transmitting tubes; four-pin socket for receiving tubes; five-pin socket for receiving tubes; and standard connections for vacuum tube bases.

The other standard, Manufacturing Standards Applying to Broadcast Receivers (C16d-1932), covers definitions of certain standard manufacturing practices as well as certain rated voltages and dimensions for component parts of radio receivers. The subjects covered in the standard are as follows: definitions of battery operated, socket powered, electric, a-c electric, and d-c electric radio receivers; selector (station selector), multiple, master, single, direct, and close selectors; volume and range; on-off switches; frequency range of radio broadcast receivers; rated voltages of socket power devices and electric radio receivers; definitions of antenna parts; antenna installation instructions; definition of solder-tests for cord terminals; dimensions and tolerances for cord tips of the cylindrical and pin type; drilling dimensions for binding posts; dimensions for speed type terminals; dimensions and tolerances for radio plugs and jacks; dimensions and tolerances of radio receiver pilot lamps of the Edison type; miniature size and connections for magnetic pick-up jack.

Personnel on Railway Motors Submitted to ASA

The personnel of the Sectional Committee on Railway Motors (C35) has been submitted to the American Standards Association for approval. It is expected that the work on standards for railway motors will go forward rapidly, since the American Institute of Electrical Engineers, sponsor for the project, has prepared a preliminary draft for consideration by the sectional committee.

The scope for the sectional committee's work is as follows:

> Definitions, classification, rating and methods of test for alternating and direct-current motors used in the propulsion of railway cars and locomotives.

Following is the personnel of the committee as submitted to ASA for approval:

N. W. Storer, Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa., *chairman;* E. L. Moreland, Jackson & Moreland, Boston, Mass.—representing the American Institute of Electrical Engineers.

H. H. Adams, Chicago Surface Lines, Chicago, Ill.; R. H. Dalgleish, The Capital Traction Company, Washington, D. C.—representing the American Electric Railway Association.

J. E. Sharpley, Virginian Railway, Princeton, Va.—representing the American Railway Association.

H. A. Currie, New York Central Railroad, New York, N. Y.—representing the American Railway Engineering Association.

S. B. Cooper, Railway Engineering Department, Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa.; M. R. Hanna, Railway Equipment Engineering Department, General Electric Company, Erie, Pa. —representing the National Electrical Manufacturers Association.

ASA Considers Broadening Scope of Project on Petroleum Products

The American Society for Testing Materials, sponsor for the project Methods of Testing Petroleum Products and Lubricants (Z11), has recently requested a slight broadening of the scope of this project. This action, resulting from a recommendation of the sectional committee, is taken in order to bring the scope into conformity with that of the newly organized committee on Nomenclature and Methods of Test of Petroleum Products of the International Standards Association.

As broadened, the scope of the sectional committee would read as follows, the new section appearing in italics:

"Methods of test of petroleum and all products derived therefrom, except tests applied to such products used as road or paving materials or for waterproofing; methods of tests of lubricants, including all materials used for lubrication when they consist either wholly or in part of petroleum products; *nomenclature of petroleum, petroleum products and lubricants except for materials excluded above*. The scope of this project excludes tests applied to organic chemicals or to products used medicinally."

Interim Revision of National Electrical Code

An interim revision of the National Electrical Code, covering non-metallic surface extensions, has been adopted under the interim revision procedure of the sectional committee having the code in charge. The new section, to be known as Section 511, reads as follows:

Section 511. Non-metallic surface extensions.

a. Semi-portable two-wire assemblies approved for the purpose may be used as extensions to existing convenience outlets on lighting and/or appliance branch circuits only in exposed dry locations in residence or office occupancies.

b. Attachment of such extensions to existing convenience outlets shall be by plug connectors approved for the purpose.

c. Such extensions shall be attached only to the surface of interior woodwork or plaster finish and shall not be installed as concealed wiring or run through floors or partitions or be installed where subject to moisture or corrosive vapors; nor be installed in contact with any piping, metal work, or other conductive material.

d. Such extensions shall not be made on circuits of over 150 volts.

e. Individual extensions shall not run more than 20 ft in either direction from the existing outlet, and may contain a maximum of three receptacles provided that the total outlets on the branch circuit including those on the extension are not over 12.

f. Such assemblies shall be secured between outlets to the surface wired over by tacks, screws, small nails or other approved means at intervals of not more than 6 inches, except that the assembly shall not be secured within 6 inches of a connector. The heads of such nails or screws shall not exceed in width one-half the space between the conductors in the assembly.

g. Receptacles and other fittings shall be of approved type and be secured to the surface wired over by suitable screws. The end of the assembly on such an extension shall terminate in an approved receptacle which covers the ends of the wires in the assembly. All angle bands which reduce the space between conductors shall be covered by an approved cap securely attached to the surface wired over.

h. Such extensions shall be made in continuous lengths without joint, splice, or tap, or exposed bare conductors.

Portillo Member of Committee on Petroleum Products

Ramon Lozano Portillo, chief, Laboratorio de la Secretaria de Obras Publicas, Havana, Cuba, has replaced Armando Basarrate Morales as representative of the American Society for Testing Materials on the Sectional Committee on Petroleum Products and Lubricants (Z11).

ASA Approves Enlarged Scope of Noise Measurement Project

The change in the title and scope of the project on noise measurement which was recommended to the American Standards Association by the sectional committee at its organization meeting has been approved by the ASA Standards Council. The former scope restricted the work of the committee to units, scales, terminology, and methods of measurement in the field of noise measurement, while the new scope permits fundamental standardization in the general field of acoustics.

The new title of the project is Acoustical Measurements and Terminology (Z24) and the scope is as follows:

> Preparation of standards of terminology, units, scales, and methods of measurement in the field of acoustics.

Two new subcommittees will be appointed as a result of the enlarged scope of the project, one to cover sound insulation and absorption, the other to cover fundamental sound measurements.

ASA Staff Meets With A.R.E.A. Committee

A broad panorama of the work of the American Standards Association as it affects the railways was presented by the ASA staff before a meeting of the Committee on Standardization of the American Railway Engineering Association on May 20 in the Engineering Societies Building in New York.

The major part of the meeting, which was held under the chairmanship of J. C. Irwin of the Boston and Albany Railway, who is chairman of the Committee on Standardization, was devoted to a discussion of the value of American Standards to the railways. Following a description of ASA organization and methods of work by P. G. Agnew, ASA secretary, Cyril Ainsworth, assistant secretary and safety engineer, told of the Association's safety code program and the importance of a number of national safety codes in railway accident prevention work. John Gaillard, mechanical engineer of the ASA staff, reviewed the standardization work on fits and tolerances and on gaging in which the railways, in common with almost all other industries, are greatly concerned. The work of ASA in the field of materials specifications and methods of test, together with mining standards which are of interest to certain railroads, was described by H. M. Lawrence, mining engineer of the ASA staff.

In the subsequent round-table discussions, the A.R.E.A. Committee reviewed a number of subjects to determine whether ASA procedure could profitably be applied to their development.

About 20 engineers from nearly as many railroads were present at the meeting.

Standardization of Oil Nomenclature

The American Petroleum Institute has recently announced the formation of a committee to standardize nomenclature and production records as a part of the Institute's central committee on drilling and production practice. J. French Robinson, Lycoming Natural Gas Company, Wellsboro, Pennsylvania, has been designated as the national chairman. To obtain maximum cooperation, the committee has been subdivided into representation from four districts—the eastern district, comprising the fields of Pennsylvania, West Virginia, and Ohio; the mid-continent district; the southwestern district; and the Californian district. It is expected that this committee will develop uniform terms applicable to the petroleum industry of the entire country.

Revision of Illuminating Standards Submitted to ASA

A revision of the 1925 edition of *Illuminating Engineering Nomenclature and Photometric Standards* has been submitted to the American Standards Association for approval as American Standard by the proprietary sponsor, the Illuminating Engineering Society. These standards have been referred to the Electrical Standards Committee for recommendations on approval to the Standards Council.

Simplified Practice Recommendation for Packaging Railway Material

Copies of Simplified Practice Recommendation R65-31, Packaging of Overhead Electric Railway Material, have just been received from the Government Printing Office and are for sale at five cents each. These recommendations cover the packaging of 20 items, including pole bands, braces, crossovers, frogs, insulators, pins, sleeves, and switches.